

Referee's report on the dissertation of Mgr. Ján Šubjak:

Photometric and spectroscopic characterization of substellar companions to stars

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Since the discovery of the first bona-fide brown dwarfs and extra-solar planets in 1995, the field of substellar objects has progressed considerably, both from theoretical and observational viewpoints. Recent developments in the physics entering the modeling of these objects have led to significant improvements in the theory and to a better understanding of these objects' mechanical and thermal properties. This theory can now be confronted with observations obtained by space missions like, TESS, PLATO, GAIA, etc. We observe rapid growth of transiting substellar objects beyond our expectations which radii and often also masses are measured with great precision. This fact reflects a strong interest in discovering and investigating brown dwarfs (BDs) and extrasolar giant planets (EGPs). Therefore the topic of dissertation is very actual.

The main goal of submitted dissertation is the detection and characterisation of transiting BDs and EGPs.

Methods: To fulfill the objectives of the dissertation, the author uses various techniques to determine stellar mass, radius and age, which are crucial to derive the parameters of a companion and discuss its formation and evolution. Furthermore, the author can study tidal interactions between the companion and the host star for each system, which provide additional methods to constrain the formation.

Results: Author presented (i) the discovery of the first transiting BD from the TESS space mission (Šubjak et al., 2020). There is showed that the host star is a metallic-line A-type star, an Am star, which makes TOI-503b the first brown dwarf found around such a stellar type. This work also discusses tidal interactions between a brown dwarf and a host star and uses brown dwarf parameters to test substellar evolution models. (ii) the discovery of the youngest transiting Saturn-mass planet (Šubjak et al., 2022). The work explores various stellar age-dating techniques and discusses what we can learn from tidal interactions even though the planet is not massive enough to be expected to have formed by gravitational instability. Particularly interesting is that TOI-1268b has mass and radius similar to that of Saturn, despite the much younger age between 110 – 380 Myr. (iii) the search for planets in systems with wide BD companions. The work also compares parameter distributions of planets around single stars, planets around stellar binaries and planets in systems with wide BD companions to study how wide BD companions affect planetary systems.

The results of dissertation show the fulfillment of its objectives.

I have couple of questions for the author:

1) In the paper Šubjak et al. (2020) you have presented the analysis of the first BD (TOI-503b) known to transit an Am star. Could you indicate whether any other transiting brown dwarfs have been discovered between discovery of TOI-503b and present day? If so, how would they look in the context of mass distribution over a period for transiting BDs (Fig. 12 in the paper Šubjak et al., 2020) ?

What is the most popular explanation of transiting BDs absence in the range of 40-50 M_J.

2) Concerning TOI-1268b (Šubjak et al., 2022) you have detected 15 transiting light curves from the TESS photometry. The number of transits is not negligible for possible TTV analysis. Did you consider to improve your parameters using this method? If not, why?

I have no other significant comments on the content or form of the dissertation. Mgr. Ján Šubjak published the results of his dissertation as the first author in 3 refereed papers. This fact shows the good level and significance of the achieved results from an international point of view.

Conclusion:

The submitted dissertation fulfills the requirements set for graduates of doctoral studies. In my opinion, it shows the competence of the student Mgr. Ján Šubjak for independent scientific work.

Therefore, I recommend the dissertation of Mgr. Ján Šubjak for the defense, and evaluate it with classification grade passed.

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